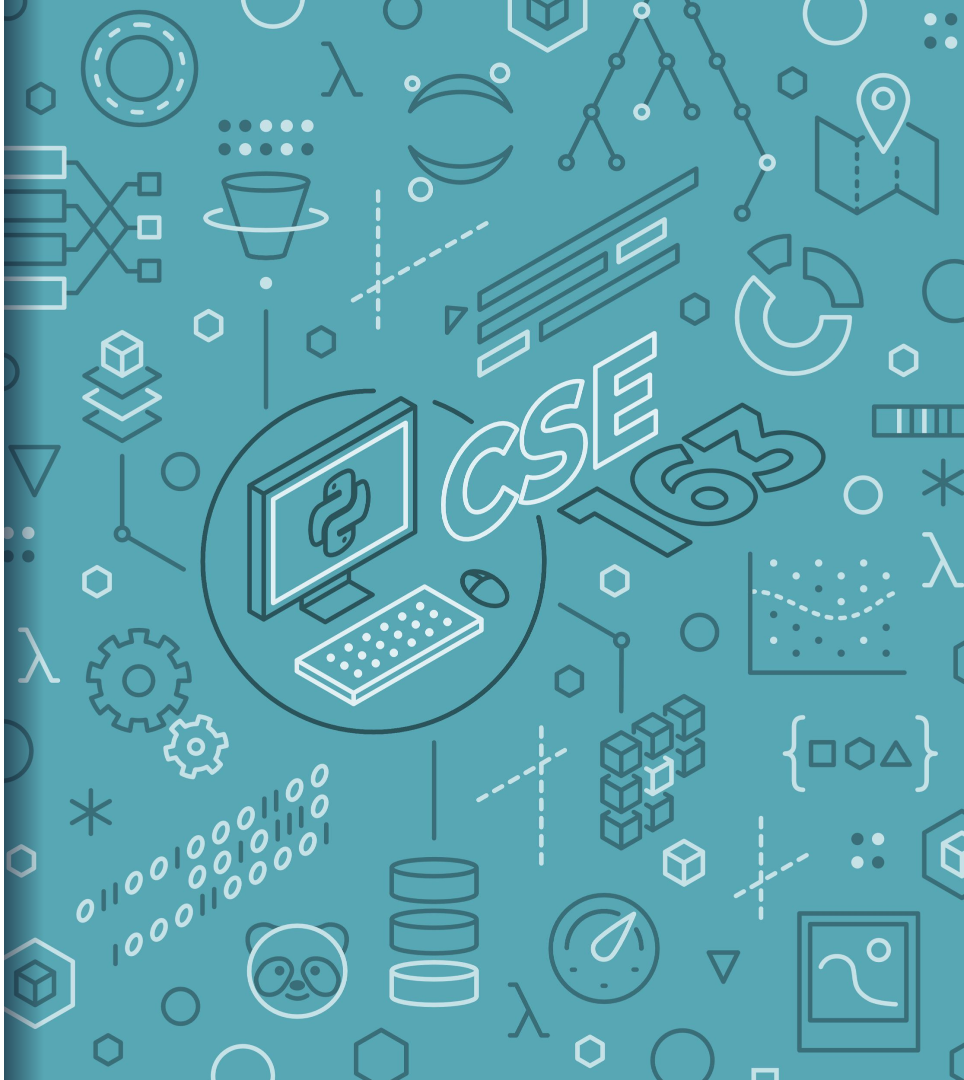
CSE 163

Numpy + Images

Hunter Schafer



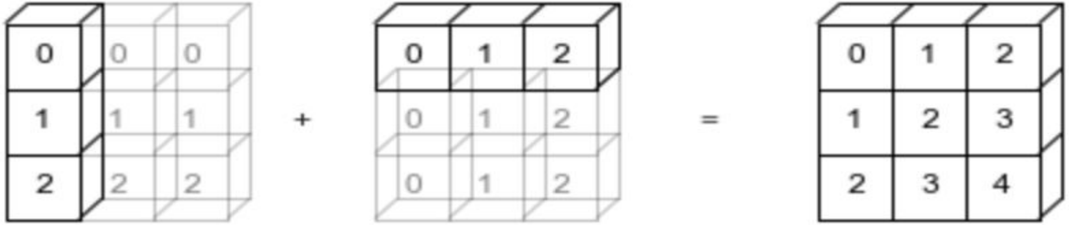
What Happened?

```
a.shape = (3, 1)
b.shape = (3,)
```

```
a.shape = (3, 1)
b.shape = (1, 3)
```

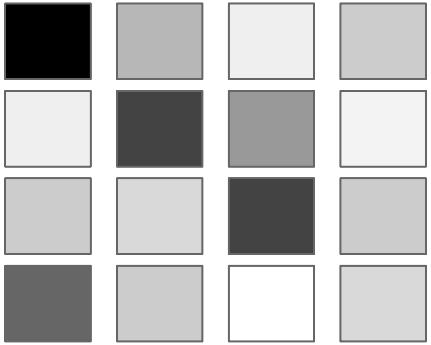
```
a.shape = (3, 3)
b.shape = (3, 3)
```

np.arange(3).reshape((3,1))+np.arange(3)



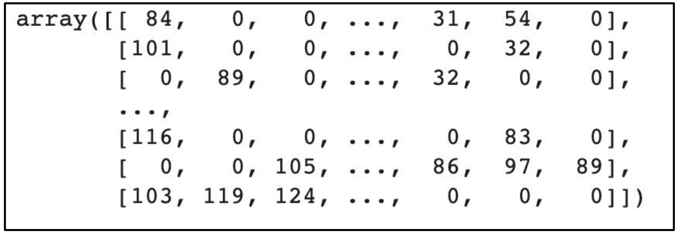
Images as Matrices

Grey-scale images can be represented as matrices.



□ **Grey-scale: 255**

■ **Grey-scale: 0**

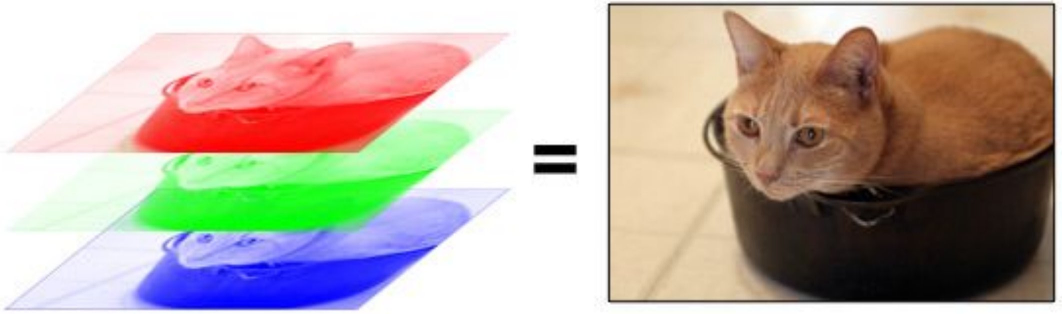


```
array([[ 84,   0,   0, ...,  31,  54,   0],
       [101,   0,   0, ...,   0,  32,   0],
       [  0,  89,   0, ...,  32,   0,   0],
       ...,
       [116,   0,   0, ...,   0,  83,   0],
       [  0,   0, 105, ...,  86,  97,  89],
       [103, 119, 124, ...,   0,   0,   0]])
```

Color Images

When you overlap each color channel, it creates a picture we are used to seeing.

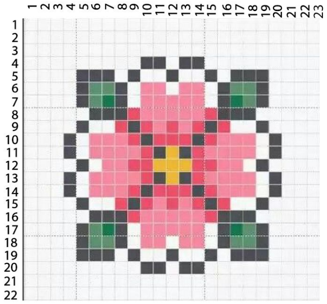
- Pixels on your monitor let out specified R/G/B light

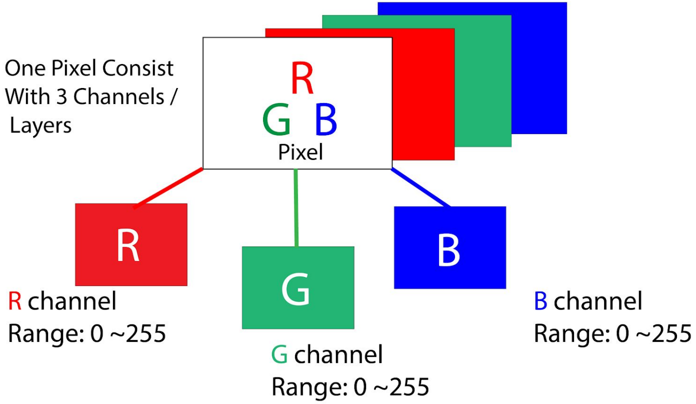


Color Images

Each pixel coordinate (x, y) contains 3 values ranging for intensities of 0 to 255 (8-bit)
- Red - Green - Blue

Mixing different intensities of each color gives us the full color spectrum.





One Pixel Consist With 3 Channels / Layers

R G B Pixel

R

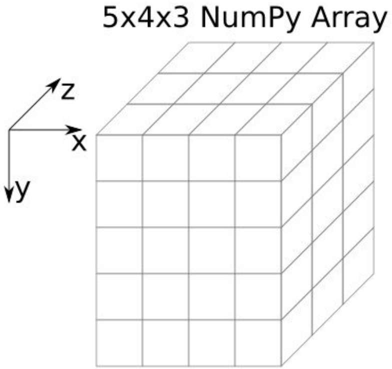
G

B

R channel
Range: 0 ~255

G channel
Range: 0 ~255

B channel
Range: 0 ~255



Color Demo

Goal: Manipulate image values to change color of image

- Show how changing colors changes image
- Write a method to “circle” object in the middle of a picture

Note

- Often “global” transformations of an image can be done without loops, probably speeding up the program

Colab

Brain Break

Convolution

When wanting to use “local” information, we need to use a sliding window approach (i.e. a **convolution**)

Move the sliding window across the image, and compute the sum of the element wise product of the window (kernel) and image

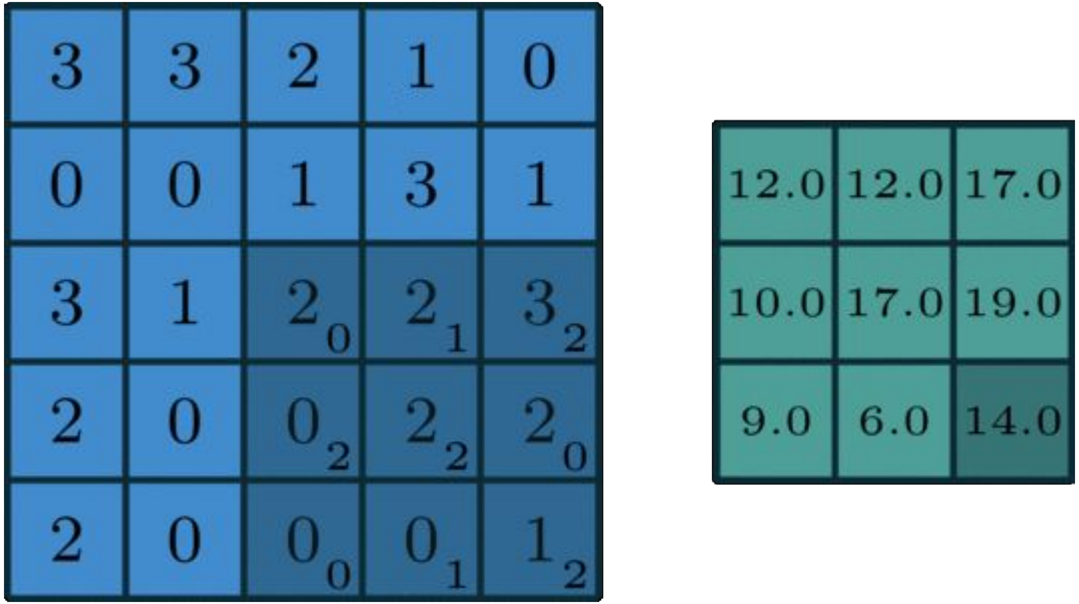
Image

3	3	2	1	0
0	0	1	3	1
3	1	2	2	3
2	0	0	2	2
2	0	0	0	1

Kernel

0	1	2
2	2	0
0	1	2

Convolution Example



3	3	2	1	0
0	0	1	3	1
3	1	2_0	2_1	3_2
2	0	0_2	2_2	2_0
2	0	0_0	0_1	1_2

12.0	12.0	17.0
10.0	17.0	19.0
9.0	6.0	14.0

Common Kernels

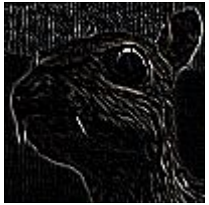
What do the numbers in the kernel do?

Identity

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

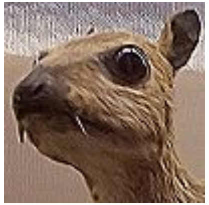
Edge Detection

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$



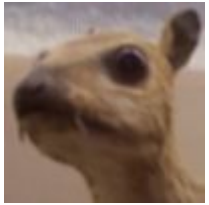
Sharpen

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$



Box Blur

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$



Poll Everywhere

Think

1 minute

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What is the result of applying a convolution using this kernel on this image?

Image

1	2	3
4	5	6
7	8	9

Kernel

1	1
0	2

Poll Everywhere

Pair

1.5 minutes

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What is the result of applying a convolution using this kernel on this image?

Image

1	2	3
4	5	6
7	8	9

Kernel

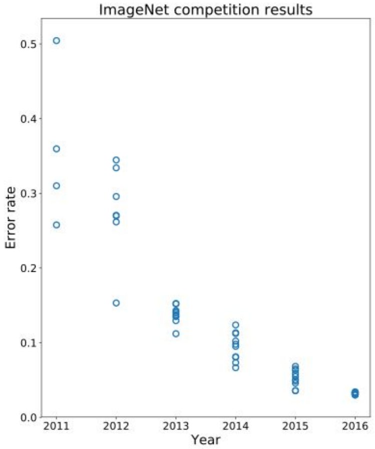
1	1
0	2

Image Classification

For a really long time, image classification was done by painstakingly crafting these features (like edge detectors), by hand.

This kind of worked, but we quickly hit our peak using this method.

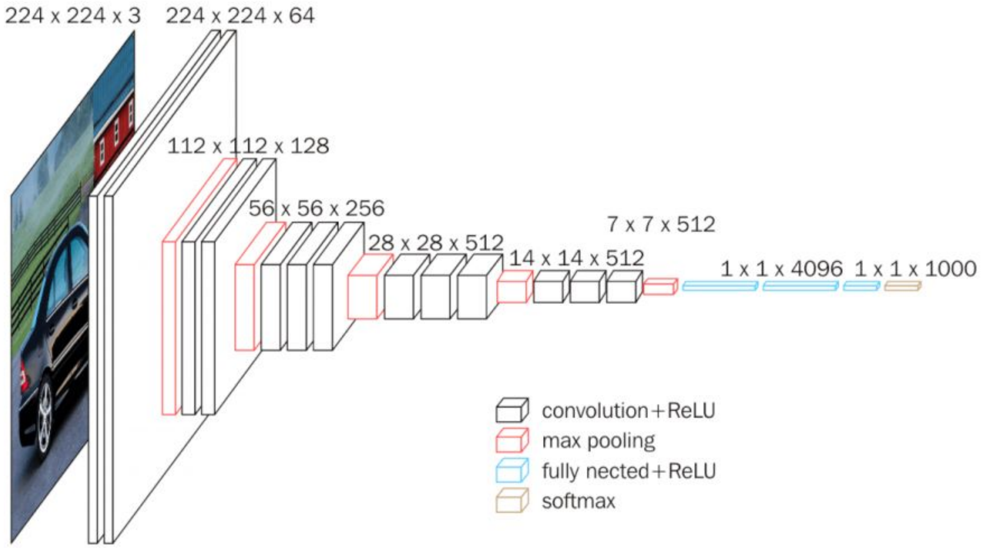
Then came the buzz-word... deep learning



Convolutional Neural Networks

Has layers that perform functions like a convolution or classification

- Each layer is connected to the next (network)

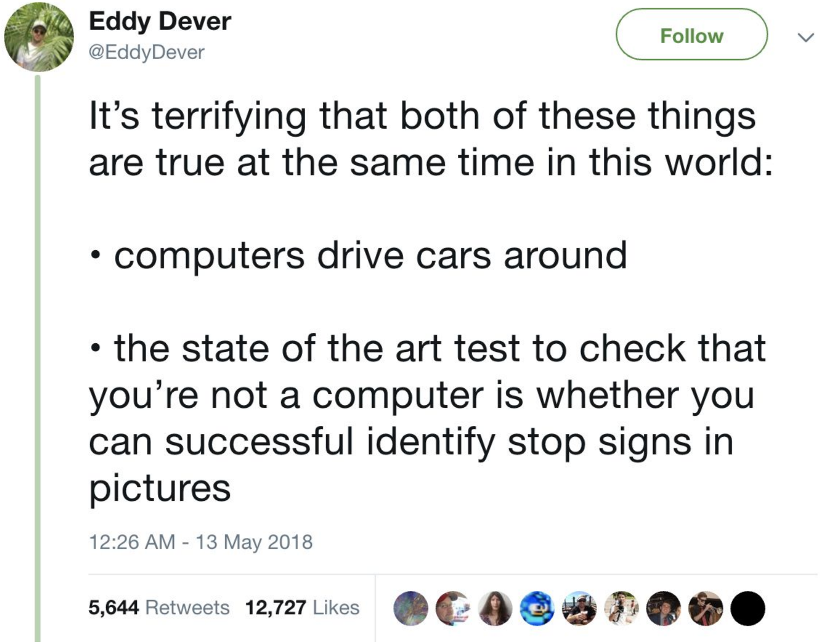


Specifics are not important here, just general idea of learning kernels

Image Classification

- Is this a solved problem?
  - We get pretty decent error rates on challenges like ImageNet
- What we can’t do
  - Sometimes can’t generalize to other real-world datasets
  - Adversarial attacks

“panda”
57.7% confidence



Eddy Dever
@EddyDever

It’s terrifying that both of these things are true at the same time in this world:

• computers drive cars around

• the state of the art test to check that you’re not a computer is whether you can successful identify stop signs in pictures

12:26 AM - 13 May 2018

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Why Convolutions?

A fundamental operation for image processing that shows up in many applications

- Edge detection
- Convolutional Neural Networks (CNN)
- Template Matching - Your Homework